



REMEDIATIONS CHEMICAL OXIDATION ...The Field as a Laboratory

OBJECTIVE

Chemical Oxidation has long been recognized as an effective method of degrading many organic contaminants under laboratory conditions to their non-toxic basic components like carbon dioxide and water. Over the past decade, *in-situ* and *ex-situ* chemical oxidation has become an increasingly widespread tool for the remediation of soil and groundwater impacted with petroleum hydrocarbons and chlorinated solvents. Although much success has been achieved, regulators have become increasingly concerned about instances when the uncontrolled use of chemical oxidants has resulted in the mobilization of previously adsorbed contaminants (sometimes resulting in the generation of NAPL), the generation of vapors and associated intrusion into occupied buildings, “rebound” of elevated contaminant concentrations after cleanup reportedly was achieved, and alteration of physio-chemical conditions in the subsurface resulting in the inhibition of other remedial approaches such as biodegradation and monitored natural attenuation. Recent revisions to the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000, limit potential applications of Chemical Oxidation in some potentially sensitive settings such as near residences and schools.

The staff of **Clean Properties** is experienced in successfully using Chemical Oxidation as a remedial tool but recognize that applications must be made in a controlled manner at appropriate settings, with contaminant and environmental conditions monitored before and seasonally after application of the selected oxidant.

THE TOOLBOX

The chemical oxidants most commonly used in Massachusetts have been Hydrogen Peroxide (Fenton’s Reagent), Permanganate, Persulfate, Percarbonate, and Ozone — in approximate order of the number of uses based on MassDEP reports reviewed. Each oxidant is effective on a differing range of contaminants, operates along different reaction paths favored by different environmental conditions and catalysts and inhibited by different competing chemicals, and has different risks of byproduct contaminant generation and persistence. **Clean Properties’** geochemists and engineers are knowledgeable in the evaluation and selection of chemical oxidants appropriate to specific contaminants and environmental conditions. **Clean Properties** also has experience with both *ex-situ* and *in-situ* applications of chemical oxidants and can assist you in selecting the most appropriate application approach for your site.

Clean Properties is one of the few Massachusetts consultants to have experience using Ozone, which has the advantage of oxidizing contaminants both in the dissolved phase and in the gaseous phase — an advantage for degrading volatile contaminants. Ozone has proven to be an effective oxidant in the unsaturated zone; however, care must be taken to control residual ozone and other vapor intrusion to overlying occupied buildings. **Clean Properties** owns ozone generators, monitors, and injection equipment suitable for application under most conditions.

THE KNOW-HOW

Clean Properties’ experience with a range of chemical oxidants has lead to an understanding of many of the conditions that can limit the effectiveness of the approach and solutions to circumvent those limitations. Historically, one of the greatest challenges in application of *in-situ* chemical oxidation has been getting the oxidant into contact with the contaminants in the subsurface. **Clean Properties** has the hydrogeologic and engineering expertise to design injection strategies reflective of site-specific soil type, porosity, transmissivity, and degree of saturation. **Clean Properties** also has developed supplemental fracking techniques to enhance the reach of injections, where necessary. Although chemical reactions generally proceed rapidly upon contact of the selected oxidant with the contaminant, degradation pathways and products often vary widely based on the influence of environmental conditions (pH, redox potential, catalyzing and inhibiting agents, etc.). **Clean Properties** is equipped to assess and monitor field conditions and has the expertise in geochemistry to adjust field conditions to be favorable to desired degradation pathways in a variety of circumstances. **Clean Properties** employs treatability testing to assure that it selects the appropriate oxidant for contaminant and field conditions.

EXPERTISE

Clean Properties has applied *in-situ* and *ex-situ* chemical oxidation as part of its remedial strategies at several sites impacted with chlorinated solvents.